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BULK AND SACK HANDLING OF GRAIN IN THE PACIFIC COAST STATES

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INTRODUCTION

The origin and development of the grain producing and marketing industry on the Pacific coast is an interesting story of industrial growth beginning with pioneer conditions and developing into grain production in mammoth proportions, and then gradually giving way to other forms of agriculture as the country developed.

When the rush for gold subsided somewhat, thinking men recognized that the agricultural resources of the new country far exceeded its mineral deposits. In the seventies the remarkable discovery was made that by a new method known as dry-land farming phenomenal yields of grain could be produced on the broad, dry inland prairies east of the coast mountains. These great plains were rapidly developed into vast wheat fields. The production of wheat soon exceeded the needs of the Pacific coast population. The wheat export business naturally developed to provide a market for the surplus grain. Conditions in those early days seemed to favor, if not to necessitate, the use of sacks for transporting Pacific coast grain.

But changing conditions bring changing needs. This circular outlines the changes that have taken place and the economic advantages under conditions to-day, of handling grain in bulk, instead of sacks, from the farm through to export.

WHY THE SACK SYSTEM ORIGINATED

The usual absence of rain in the grain sections of the Pacific coast made it possible to leave grain in bags in the fields and in piles at country shipping points for months after the harvest, unprotected by roofs or covering.

In the early days there were few railroads. Much of the grain was moved in wagons over poor roads to river banks and there loaded on barges for movement to deep-water terminals. There were no grain elevators, therefore, the simplest means of moving the grain was to put it in bags. Grain in bags accommodated itself to almost any form of transportation whether on land or water. Sailing vessels preferred grain in bags for the long voyage around the Horn. In fact, underwriters refused to insure sailing vessels or their cargoes if the grain was in bulk. The use of grain bags was therefore of natural growth, and the system became thoroughly entrenched.

MODERN TRANSPORTATION DEVELOPMENTS FAVOR BULK SYSTEM

Conditions that encouraged or necessitated the use of sacks for grain have changed with the years. The size, motive power, and facilities of ships are now favorable to the handling of bulk grain. The Panama Canal has shortened the voyage from the Pacific coast to Europe, and no longer do insurance companies favor grain in bags. This is evidenced by the fact that the wheat exports from the Pacific coast are practically all in bulk at the present time (1930).

PROGRESS OF BULK HANDLING IN PACIFIC COAST STATES

In the keen competition on the world wheat markets the great factor for success must be lowered production costs. Producers on the Pacific coast are in a position to reduce their production costs by handling their grain in bulk from the threshing machine to the terminal markets. Many of the efficient farm managers have been among the first to recognize the possibility of handling their grain more easily, rapidly, and cheaply by use of the bulk system.

The high price of sacks and the high cost of labor during the World War stimulated a strong movement in the Pacific Coast States toward bulk grain on the farms. High construction costs during and after the war, the fact that grain dealers paid differentials in favor of sacked grain, the reduction in the cost of sacks and in the cost of labor after the war, and the sudden fall of the price of grain, retarded construction of country elevators for a time.

Construction of terminal elevators for handling grain in bulk at export points, which was stimulated by war conditions, has been continued. The progress that the bulk method of handling grain has made in the Pacific Coast States during the last 10 years is based largely on this terminal elevator construction, which now makes bulk shipments from the country possible.

INCREASE IN EXPORTS OF BULK GRAIN

The quantity of bulk grain exported from Columbia River markets to foreign countries increased from 1.4 per cent to 97.3 per cent of total exports from these markets during the 4-year period 1921-1925. In the 5-year period since 1925 the bulk-grain exports have not been less than 93.7 per cent of the total quantity of grain exported. (Table 1.)

TABLE 1.—Wheat exported (in foreign commerce) from Columbia River markets, 1919-20 to 1929-30

Crop year	Wheat exported					
	Total	In bulk		In sacks ¹		
		Total	Percent- age of total exports	Total	Percent- age of total exports	Number exported
	<i>Bushels</i>	<i>Bushels</i>		<i>Bushels</i>		
1919-20.....	2,920,374	424,040	14.5	2,496,334	85.5	1,109,482
1920-21.....	24,731,891	336,000	1.4	24,395,891	98.6	10,842,618
1921-22.....	35,164,712	2,882,273	8.2	32,282,439	91.8	14,347,751
1922-23.....	15,406,752	7,679,625	49.8	7,727,127	50.2	3,434,279
1923-24.....	25,516,090	14,872,116	58.3	10,643,974	41.7	4,730,655
1924-25.....	12,901,000	12,550,764	97.3	350,236	2.7	155,660
1925-26.....	16,564,603	16,207,528	97.8	357,075	2.2	158,700
1926-27.....	28,726,412	26,919,466	93.7	1,806,946	6.3	808,087
1927-28.....	39,212,201	38,082,380	97.1	1,129,821	2.9	502,143
1928-29.....	22,929,463	22,208,392	96.9	721,071	3.1	320,476
1929-30.....	20,382,509	20,277,027	99.5	105,482	0.5	46,881

¹ A sack of wheat is estimated to be 2.25 bushels.

WHEAT RECEIPTS AT TERMINALS FROM COUNTRY POINTS

Following the practically complete change to the bulk method of exporting grain from Columbia River markets since the crop year 1924-25, there has been, in general, a small increase in the quantity of bulk grain shipped from the country points to these terminals. (Fig. 1 and Table 2.) The crop year 1929-30 showed the largest percentage of country-point shipments of bulk grain to Oregon terminal markets that has ever occurred in one year. However, fluctuations in the receipts of bulk grain are probably due somewhat to the variation in the quantity of Montana wheat, which is practically all bulk grain, that came to the Columbia River terminals.

TABLE 2.—Receipts of wheat, in bulk and in sacks, at Columbia River markets, 1920-21 to 1929-30

Crop year	Receipts of wheat					
	Total	In bulk		In sacks ¹		
		Total	Percent- age of total receipts	Total	Percent- age of total receipts	Number of sacks
	<i>Bushels</i>	<i>Bushels</i>		<i>Bushels</i>		
1919-20.....	14,431,045	3,812,623	26.4	10,618,422	73.6	4,719,299
1920-21.....	29,647,576	5,931,143	20.0	23,716,433	80.0	10,540,637
1921-22.....	41,837,348	7,565,157	18.1	34,272,191	81.9	15,232,085
1922-23.....	23,584,432	6,991,119	29.6	16,593,313	70.4	7,374,806
1923-24.....	36,824,093	7,355,243	20.0	29,468,850	80.0	13,097,267
1924-25.....	20,735,973	5,635,784	27.2	15,100,189	72.8	6,711,195
1925-26.....	26,353,935	6,171,793	23.4	20,182,142	76.6	8,969,841
1926-27.....	33,827,563	9,989,628	29.5	23,837,935	70.5	10,594,638
1927-28.....	44,561,574	11,775,450	26.4	32,786,124	73.6	14,571,611
1928-29.....	28,968,838	9,320,724	32.2	19,648,114	67.8	8,732,495
1929-30.....	27,910,859	10,575,978	37.9	17,334,881	62.1	7,704,392

Compiled from records of the Oregon State Grain Inspection Department.

¹ A sack of wheat is estimated to be 2.25 bushels.

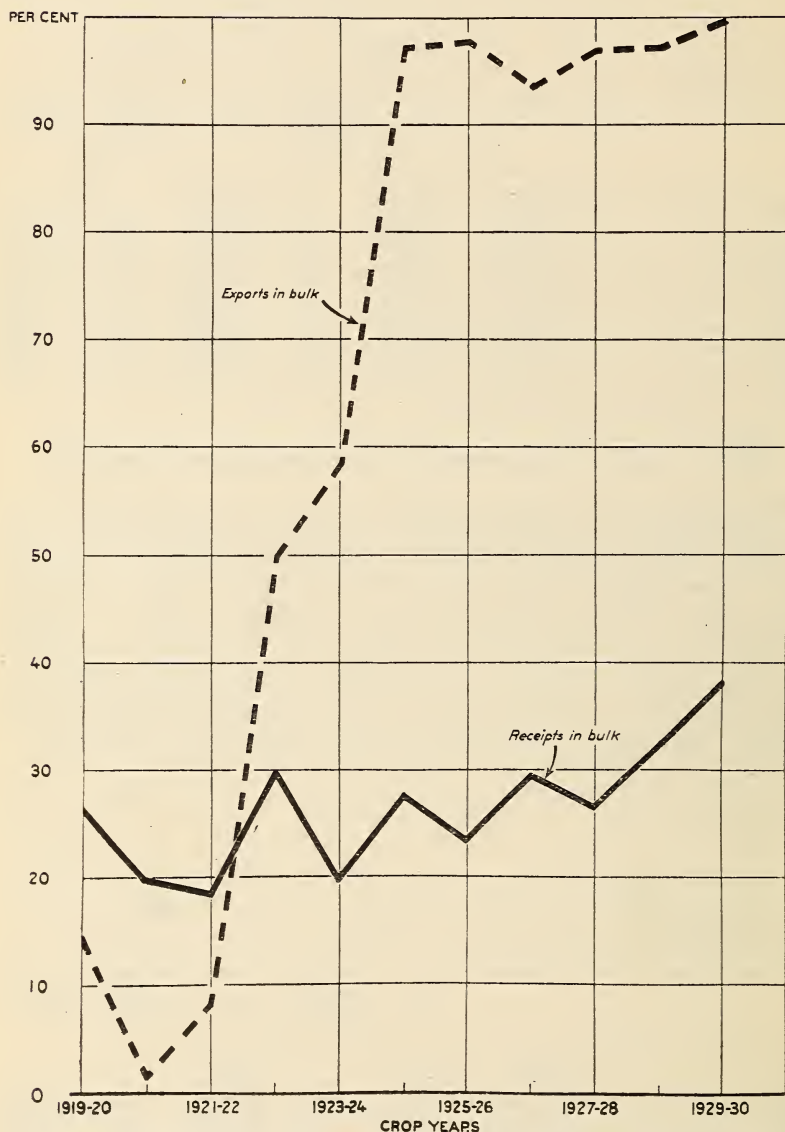


FIGURE 1.—PERCENTAGE OF WHEAT EXPORTED IN BULK FROM COLUMBIA RIVER EXPORT MARKETS DURING STATED CROP YEARS

The proportion of wheat received in bulk is, in general, increasing. Practically the entire exports are now being shipped in bulk

SAVING ON THE FARM THROUGH BULK HANDLING¹

A bag of grain is lifted six to ten times in passing from the thresher to the elevator or the car. The order of operations is as follows: "Jigging," sewing, picking up, and hauling to the side of the field, piling, taking from pile, and hauling to the warehouse or car, loading on truck or into car door, and piling in warehouse or in car. If the sacks are piled in a warehouse, from two to four additional handlings are required to remove the sacks from the pile and load them into cars.

When handled in bulk, the grain is lifted and moved only by mechanical power. First, it flows by gravity or is transferred mechanically from the grain box of the thresher or combine into the wagon or truck. By means of either a stationary or a small portable elevator, the bulk grain is placed in farm storage bins, or granaries,

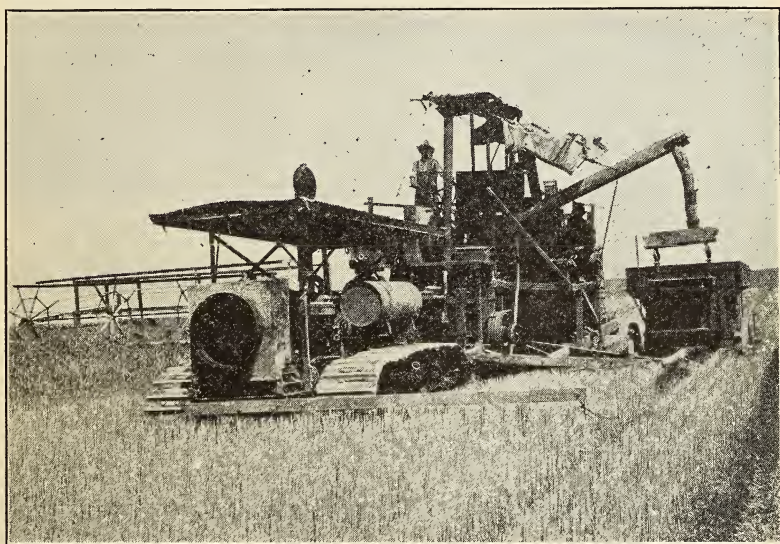


FIGURE 2.—A motor truck receiving bulk grain from a combine in motion on a California farm

or directly into freight cars. Under favorable conditions hillside bins can be used which eliminate the need for a portable elevator for filling and emptying the bins. If a country elevator is near at hand the bulk grain can be handled by hauling it from the combine or thresher direct to the elevator. One or two men with teams or trucks can handle more grain in bulk and with far greater ease than can three to five men in the same time with equivalent handling equipment, if the grain is in sacks. (Figs. 2, 3, 4, and 5.)

Studies conducted on approximately 45,000 acres of grain land in California in the harvesting seasons of 1923 and 1924 indicate a lower labor cost for harvesting and hauling grain on the farm in bulk.

¹ The comparative cost figures of harvesting and handling grain in bulk and in sacks given in this circular are based on a study of the costs on farms that were already equipped and were actually harvesting and handling grain either in bulk or in sacks. A study is now being undertaken by the Bureau of Agricultural Economics in cooperation with the agricultural experiment stations of Washington, Oregon, and Idaho to ascertain the cost of converting farm sack-grain harvesting, handling, and storage equipment into bulk equipment.

Thirteen studies made on combines using the bulk method show an average labor cost for harvesting of \$0.58 per acre, the corresponding

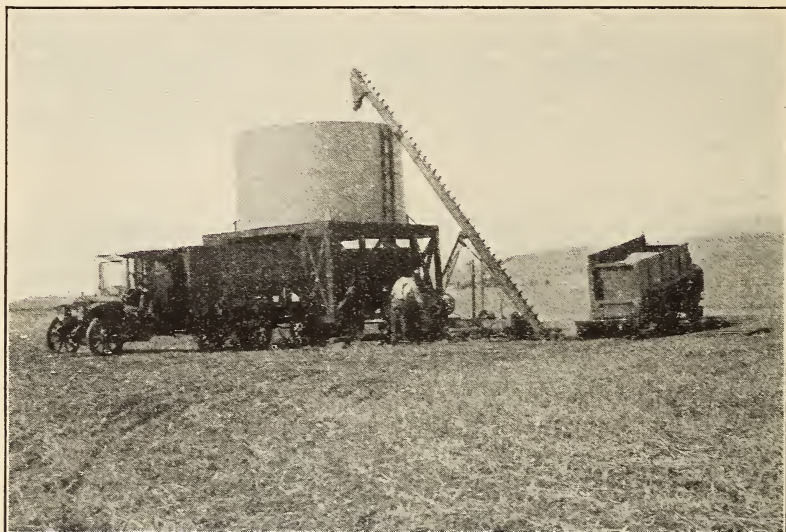


FIGURE 3.—Transfer bin used in handling bulk grain on the farm. Horse and wagon or light trucks make short hauls from thresher to bin. Truck and trailer make long hauls to elevator

labor expenditure being 0.92 man-hour. Twenty-three studies of combines using the sack method show an average labor cost of \$1.57 per acre, the corresponding labor expenditure being 2.24 man-hours.

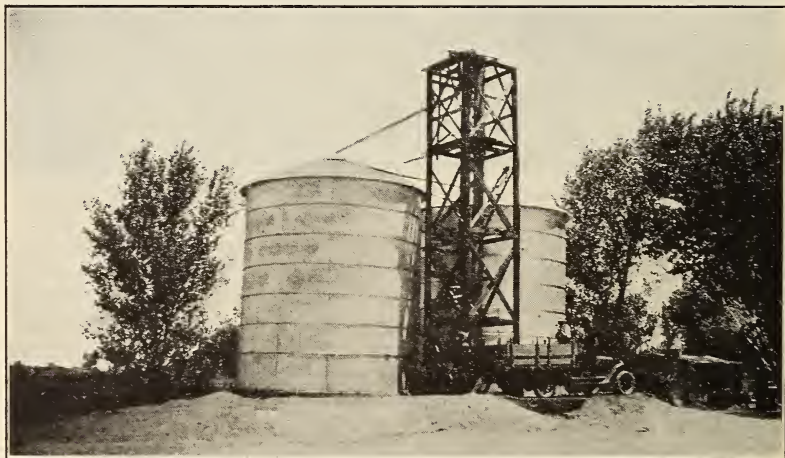


FIGURE 4.—Farm grain bins equipped with grain-elevating machinery

The saving at the harvester, made by using the bulk method, was \$0.99 per acre or a saving of 1.32 man-hours per acre.

The cost of labor for operating combines includes the wages and board of the crew. The crew on the large-sized bulk-handling com-

bines consists of a tractor driver, header-operator, and separator tender. The crew for sack handling requires one to three additional men to jig and sew the sacks. (Fig. 6.)



FIGURE 5.—Farm grain elevator equipped with cleaning machines and scales, suitable for large farming operations



FIGURE 6.—Picking up and hauling sacked grain from field harvested with a combine

The cost of sacks on these farms during the period of the investigation was approximately 14 cents each, and twine for sewing sacks cost about 0.5 cent per sack.

The cost of handling empty sacks and twine from the railroad to the farm and threshing machine, although not included in the preceding analysis, is an item of cost which should be mentioned as it amounts to about 3 cents per acre for 15-sack-per-acre yields.

The custom rate for hauling bulk grain from combines varied, but was generally found to be approximately 50 cents per ton less than the rate for hauling grain in sacks. In some cases the rates for hauling bulk and sacked grain were the same.

The saving per bushel, calculated from the above unit savings by using yield records of the California crop for barley and wheat for the years 1923 to 1927, is shown in Tables 3 and 4.

Table 3 shows that during the period 1923 to 1927 the estimated saving by handling barley in bulk varied from a minimum of 10.7 cents per bushel in 1925 when the yield was 31 bushels per acre to a maximum of 12.02 cents per bushel in 1924, when the yield was 21.9 bushels per acre.

TABLE 3.—*Estimated saving in cost of handling barley on farms in California, if bulk system had been used, 1923-1927*

Year	Yield per acre		Estimated saving in cost per acre for—					Saving per bushel
	Bulk	Sacks ¹	Sacks ¹	Twine	Hauling	Harvesting	Total	
	<i>Bushels</i>	<i>Number</i>	<i>Dollars</i>	<i>Dollar</i>	<i>Dollar</i>	<i>Dollar</i>	<i>Dollars</i>	<i>Cents</i>
1923.....	30.2	13.13	1.84	0.065	0.361	0.99	3.256	10.78
1924.....	21.9	9.52	1.33	.051	.262	.99	2.633	12.02
1925.....	31.0	13.48	1.89	.067	.371	.99	3.318	10.70
1926.....	30.0	13.04	1.83	.065	.359	.99	3.244	11.81
1927.....	27.5	11.96	1.67	.060	.329	.99	3.049	11.09
Average.....	28.1	12.23	1.71	.062	.336	.99	3.10	11.28

¹ A sack of barley is estimated to be 2.3 bushels.

TABLE 4.—*Estimated saving in cost of handling wheat on farms in California, if bulk system had been used, 1923-1927*

Year	Yield per acre		Estimated saving in cost per acre for—					Saving per bushel
	Bulk	Sacks ¹	Sacks ¹	Twine	Hauling	Harvesting	Total	
	<i>Bushels</i>	<i>Number</i>	<i>Dollars</i>	<i>Dollar</i>	<i>Dollar</i>	<i>Dollar</i>	<i>Dollars</i>	<i>Cents</i>
1923.....	21.6	9.60	1.34	0.048	0.324	0.99	2.702	12.51
1924.....	15.0	6.67	.93	.033	.225	.99	2.178	14.52
1925.....	19.0	8.44	1.18	.042	.285	.99	2.497	13.14
1926.....	18.4	8.18	1.15	.041	.276	.99	2.457	13.35
1927.....	16.8	7.47	1.05	.037	.252	.99	2.329	13.86
Average.....	18.16	8.07	1.13	.040	.272	.99	2.433	13.48

A sack of wheat is estimated to be 2.25 bushels.

Table 4 shows that for wheat the estimated savings through handling the grain on the farm in bulk varied from a minimum of 12.51 cents per bushel in 1923 when the yield was 21.6 bushels per acre, to a maximum of 14.52 cents per bushel in 1924 when the yield was 15 bushels per acre. The average saving by handling the wheat in bulk for the 5-year period was 13.48 cents per bushel at an average yield of 18.16 bushels per acre.

Using the data given in Tables 3 and 4, a chart has been drawn to show the effect of yield per acre of wheat on the estimated saving per acre and per bushel. By using this chart the approximate savings per acre or per bushel that may be expected in changing the farm method of handling grain from sacks to bulk can be roughly calculated when the yield of grain per acre is known. (Fig. 7.)

The estimated saving per acre increases with the increase of yield because the cost of sacks, twine, and hauling is proportional to the

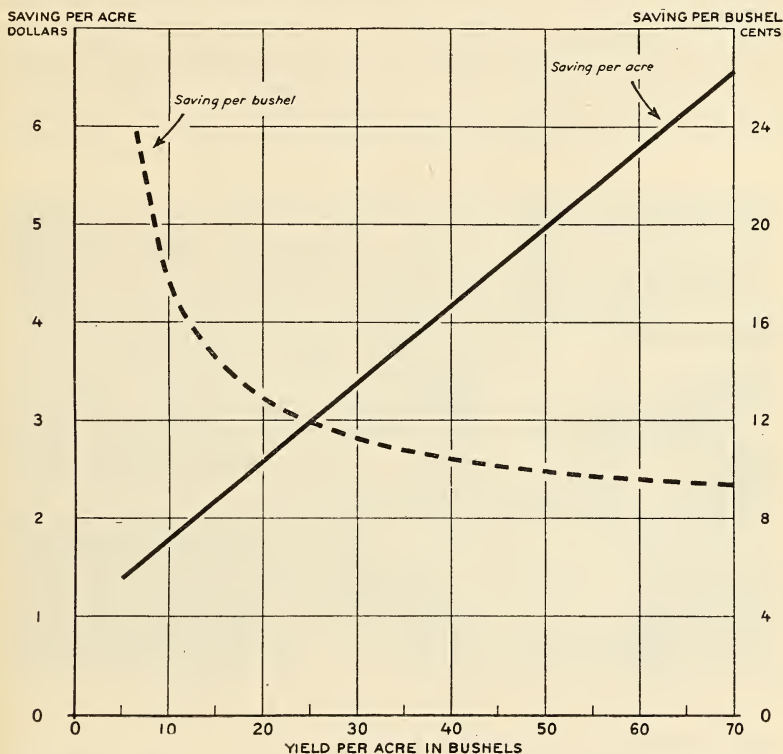


FIGURE 7.—EFFECT OF YIELD PER ACRE ON THE CHANGE IN ESTIMATED SAVINGS PER ACRE AND PER BUSHEL

An increase in yield per acre in bushels results in a decrease in saving per bushel but an increase in saving per acre

number of bushels yielded per acre. The saving per bushel, however, increases with decreased yields because the saving in labor cost is credited to a smaller number of bushels.

This indicates that the statement frequently advanced, that bulk handling would not pay on some farms because of low yields per acre, does not appear to hold true for the farm operations. When the yield per acre decreases much below 20 bushels per acre, the possible saving per bushel begins to increase rapidly.

SAVING IN MARKETING THROUGH BULK HANDLING

The saving resulting from the bulk method of handling grain is not confined to the farm. Every marketing operation that involves the handling of sacked grain is more expensive than it would be if the grain were handled in bulk. The marketing savings are not quite so apparent to the producer as are the farm savings, yet most of the marketing economies of the bulk system will probably be reflected to him eventually through reactions from competitive buying and cooperative marketing.

Studies of marketing costs have been made possible through records of wheat receipts and inspections of the Oregon State Grain Inspection Department for the years 1920 to 1928 inclusive. (Tables 5 and 6.)

TABLE 5.—*Summary of wheat-inspection receipts at Portland and Astoria, Oreg., during eight crop years 1920-21 to 1927-28*

Item	Quantity		Percent- age of total receipts
	<i>Bushels</i>	<i>Tons</i>	<i>Per cent</i>
Inspection receipts.....	257,372,494	7,721,175	
Bulk—			
Smutty.....	25,510,202	765,306	9.9
Not smutty.....	35,905,115	1,077,153	13.9
Total.....	61,415,317	1,842,459	23.8
Sacked—			
Smutty.....	81,126,271	2,433,788	31.5
Not smutty.....	114,830,906	3,444,927	44.6
Total.....	195,957,177	5,878,715	76.1
Total, smutty.....	106,636,473	3,199,094	41.4
Total, not smutty.....	150,736,021	4,522,080	58.6
Total.....	257,372,494	7,721,174	
Sacks required ¹	<i>Number</i> 87,092,079	<i>Per cent</i>	
Sacks in "bad order".....	9,006,141	10.34	
Resacks.....	1,252,653	1.44	

¹ Figured at 2.25 bushels per sack for total sacked receipts.

TABLE 6.—*Total foreign and domestic shipments of wheat from Portland and Astoria, Oreg., for the period 1920-21 to 1927-28*

	Quantity		Percentage of—	
	Bushels	Tons	Receipts	Total shipments
Shipments:				
Bulk.....	120,118,970	3,603,569	46.67	58.31
Sacked.....	85,897,847	2,576,935	33.38	41.69
Total.....	206,016,817	6,180,504	80.05	

Compiled from reports of the Pacific coast headquarters office of Federal grain supervision, Portland, Oreg.

Ten ways in which the wheat-marketing costs from the country shipping points to ships or terminals could have been reduced by the use of the bulk system are here shown. All overhead charges are included in the tariffs used.

(1) Avoids "bad-order" sacks and "resacks." At grain terminals a sack that is slightly damaged but not damaged enough to require the grain to be placed in a new sack when the car is unloaded, is referred to as a "bad-order sack." If the sack is damaged so badly that it is no longer suitable for further use, the grain is placed in a new or a used sack, and the discarded sack is classed as "resack." In the Pacific Northwest it is the custom for the licensed grain inspector to determine the number of bad-order sacks and resacks contained in any lot of sacked grain inspected. These numbers appear under "Remarks" on the United States grade certificate and are the basis on which prices are adjusted by the seller and purchaser of the grain.



FIGURE 8.—Repairing empty, bad-order sacks at terminal warehouse

Bad-order sacks and resacks are caused by conditions that can be controlled to some extent in the farming operations. Because second-hand sacks cost less than new ones, farmers frequently put their grain in used sacks but it is doubtful if this practice is a real saving. Defective sacks cause an increase in the loss of grain by leakage during the many handling operations. If high piles of sacked grain collapse because weak used sacks fail at the base of the pile, much extra handling and resacking is necessary to put the grain into a marketable condition.

To avoid bad-order sacks caused by sunburning the immediate collection of sacked grain from fields is essential. Sunburned sacks are reduced in strength to such an extent that they burst easily, and they are frequently the cause of early breaking down of piles in warehouses. The mending of sacks at the warehouse adds to the cost of marketing. (Fig. 8.)

There were 9,006,141 bad-order sacks in the Oregon wheat receipts from 1920-21 to 1927-28. The charge fixed by the Pacific Northwest Grain Dealers' Association for bad-order sacks varied from 3 to 4

cents during this period. The total was \$303,603. Resacks reported during the period numbered 1,252,653. The resack charge fixed by the Pacific Northwest Grain Dealers' Association ranged from 8 cents to 11 cents each, totaling \$103,417. The total expense for bad-order sacks and resacks for the period equaled \$407,020.

(2) Facilitates sampling, weighing, and grading. Bulk grain can be sampled and weighed with much greater speed and accuracy than can sacked grain. (Figs. 9 and 10.) Two men working together at a terminal can sample 50 to 75 cars of bulk grain a day, and one man can easily weigh this quantity in addition to performing other weighings that may be needed during the day at the elevator.

The slow rate at which sacked grain is unloaded from cars limits the number of cars one man can sample to about seven a day, and



FIGURE 9.—Obtaining a sample of bulk grain in a car by means of the bulk probe

since weighing of the sacked grain is coincident with the sampling, this is also the number of sacked-grain cars that one man can weigh in a day. Sacked grain is weighed by the hand-truck load of five sacks or about 650 pounds per weighing of wheat. In a 100,000-pound car of wheat there would be over 150 hand-truck loads. In the case of bulk grain the number of cars sampled and weighed per day averages about 25 per man whereas for the sacked grain the average is about $3\frac{1}{2}$ cars per man. Bulk grain is usually weighed in large drafts; at terminals one carload is usually weighed at a time. The weighing of the sacked wheat is less accurate as well as far more expensive. (Figs. 11 and 12.)

The charge at Portland and Astoria, that is usually referred to as the inspection fee, includes the charge for sampling, weighing, and grading the grain. This fee for bulk grain is 4 cents a ton, and for sacked grain, 6 cents. If all of the grain receipts for the period

considered had been in bulk there would have been a saving of 2 cents a ton on the 5,878,715 tons of wheat received in sacks, or a total of \$117,574.

It is an interesting fact that the charge against the farmers for bad-order sacks and resacks in the case of their sacked grain shipped to Portland and Astoria during this period was almost equal to the cost of weighing and inspecting all of the sacked and bulk grain inspected at these points during the same period.

(3) Facilitates treatment for smutty wheat. When preparing grain for export or for milling, sacks that contain smutty wheat must be



FIGURE 10.—Examining samples of grain obtained from a carload of bulk grain

opened, at terminals, in order to bulk the grain for the scouring or washing operation to remove the smut. To pay for the labor for unsacking, there is a charge of 30 cents per ton which is usually reflected to the seller of the sacked smutty grain in the form of a discount on the price. Published tariffs at the Portland elevator indicate an extra charge of 30 cents per ton in the cost of extra handling for scouring of smutty grain received in sacks. Assuming that smut was uniformly present in bulk and sacked wheat, the sacked smutty wheat that arrived in Portland and Astoria during the period under consideration amounted to 2,433,788 tons. The charge reflected to the farmer for the bulking operation on the smutty sacked grain, therefore was \$730,136. This handling cost could have been eliminated if the wheat had been shipped in bulk.

(4) Avoids freight on sacks. Freight on the weight of the 87,092,079 grain sacks which carried the 195,957,177 bushels of sacked wheat from the country points to Portland and Astoria during this period (figuring three-quarters of a pound to a sack, amounting to 65,319,059 pounds of sacks, at 20 cents per hundredweight) would amount to \$130,638. Freight on sacks is figured for one way

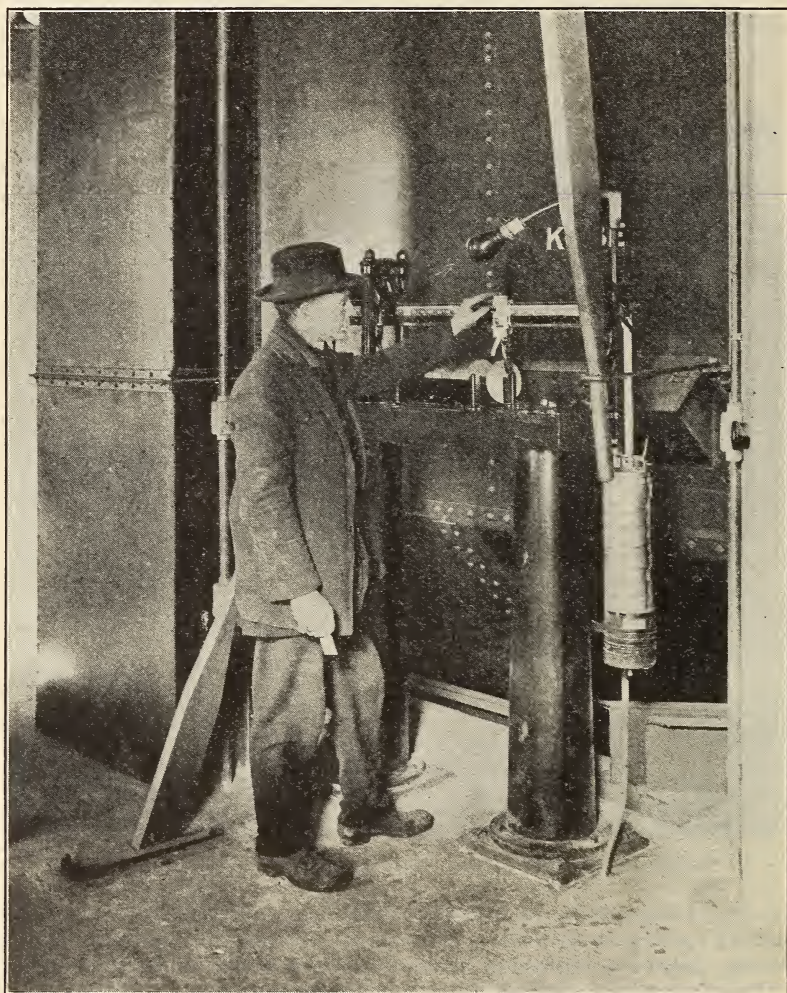


FIGURE 11.—Weighing bulk grain in carload lots at a modern grain elevator

only; the freight to the country distributing point is added to the price of the sacks sold to the farmers, and is, therefore, included in the estimated saving on the farm.

(5) Facilitates loading cars at country points. Preliminary information on the loading of sacked and bulk grain into cars at country points indicates a rather large differential in the labor and power costs in favor of the bulk method. Because of the comparatively

small number of instances recorded the figures are not given here. At Terminal No. 4 grain elevator at Portland, Oreg., the tariff for loading sacked grain into cars is 35 cents a ton, and for loading bulk grain it is 15 cents a ton. Assuming that these figures are representative of country costs, it is estimated that to load the 5,878,715 tons of sacked grain at country points cost 20 cents a ton more than if the grain had been in bulk. This represents an apparently unnecessary expenditure of \$1,175,743.

(6) Facilitates unloading cars at terminals. Investigations at modern terminals on the Pacific coast show that for labor and power it costs 34.2 cents a ton (1.026 cents a bushel) to unload and pile in a warehouse, in stacks 12 stacks high, carloads of sacked grain containing an average of 1,207.8 bushels and that it costs 8.5 cents a ton (0.255 cents a bushel) to unload, elevate, and place in bin a carload of bulk grain averaging 1,346.4 bushels. The labor and power



FIGURE 12.—Sampling and weighing sacked grain taken from cars in 5-sack hand-truck loads

cost for handling the sacked grain in the warehouse was thus four times that required for the comparable operation for bulk grain at an elevator. (Figs. 13 and 14.)

In unloading 5,878,715 tons of sacked grain from cars at an elevator instead of at a warehouse, including cutting open the sacks and bulking the grain into the track pits, and placing the grain into a bin, the labor and power cost was 21.4 cents per ton (0.642 cent per bushel) as compared with the 8.5 cents per ton (0.255 cent per bushel) for bulk grain. In this case the labor and power cost for unloading the sacked grain is two and one-half times that required for the comparable operation for bulk grain.

Part of the sacked grain considered in this study was unloaded or bulked at flour, cereal, and feed mills and elevators; the remainder was unloaded and piled in warehouses, to be bulked, conditioned, and loaded at a future time for export as either bulk or sacked grain. To July, 1927, the charge for bulking sacked grain at the elevator was 20 cents per ton more than the charge for unloading bulk grain, and

the tariff for unloading sacked grain and piling it in a warehouse was 25 cents per ton more than the charge for unloading bulk grain at the elevator. The records show that 2,576,935 tons of sacked grain was exported during the period of this study and it is estimated

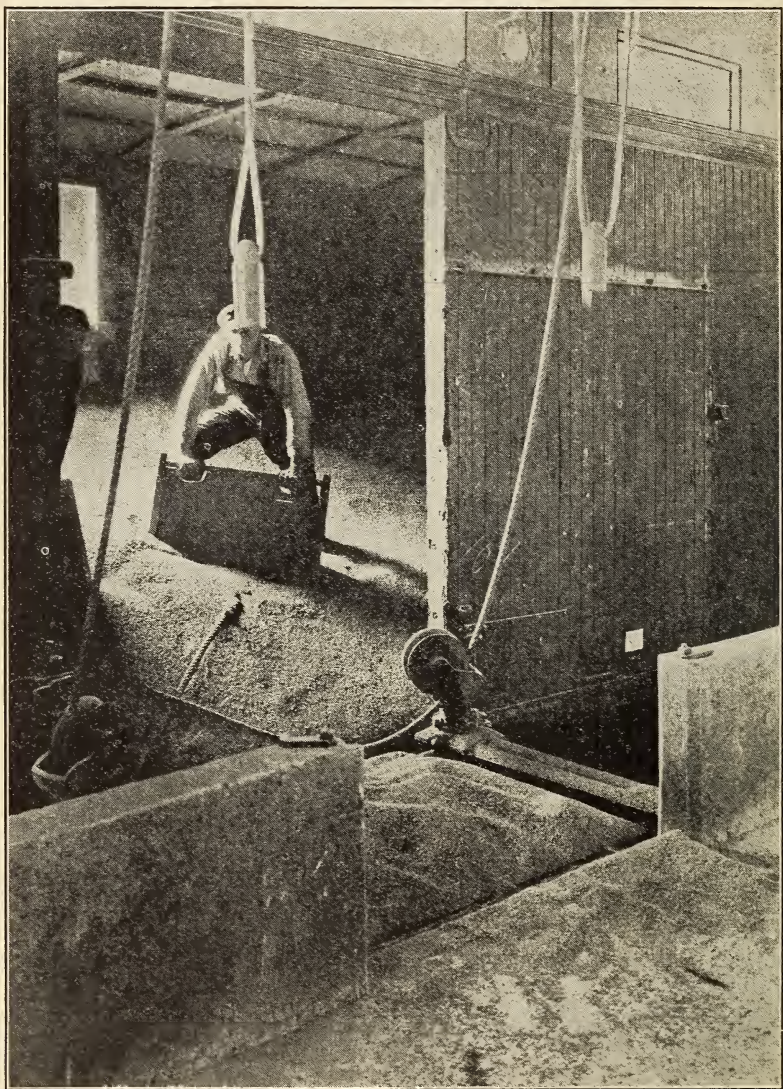


FIGURE 13.—Two men unloading a car of bulk grain with power shovels at a terminal grain elevator

that this quantity was unloaded at warehouses and piled in sacks, and that the remainder of the sack receipts, totaling 3,301,780 tons, was bulked at mills and elevators. (Fig. 15.)

The total saving on this item that could have been made, by handling all of the grain in bulk, instead of partly in bulk and partly

in sacks, is \$1,304,590 (based on the savings on 2,576,935 tons at 25 cents per ton and 3,301,780 tons at 20 cents per ton).

(7) Avoids resacking after scouring. When sacked smutty wheat that is piled in the warehouses is to have the smut removed (smutted) and again put into sacks, it must be unpiled, bulked, smutted, resacked, and repiled. The differential between smutting charges for bulk and sacked wheat is 30 cents a ton, which covers the charge for bulking the sacked wheat at the warehouse. This differential has already been credited to the advantage of bulking (p. 13); but there is still the 50 cents per ton (tariff at Terminal No. 4 grain elevator at Portland, Oreg.) that must be paid by the exporter for resacking and repiling the cleaned wheat in the warehouse. (Fig. 16.) It was assumed that the sacked wheat piled in the warehouses to be exported for each of the eight years contained the same percentage of smutty wheat as was shown by the total receipts for these years.

On the above basis, and using State inspection figures for the percentage of wheat that was smutty and Federal supervision figures for foreign and domestic shipments from Portland and Astoria for the eight years, the indication is that there was a total of 1,066,851 tons of smutty sacked wheat stored in the warehouses for export. During the 8-year period studied, some wheat may have been exported in a smutty condition under the old chamber of commerce type-sample methods. Definite information on this point does not seem to be available, but if it is assumed that a quantity of wheat equivalent to 1,066,851 tons was resacked after smutting at 50 cents a ton, a saving of \$533,426 would have been made had the wheat been in bulk.

(8) Facilitates delivery to ships. The charge at Terminal No. 4 grain elevator at Portland for delivering grain to ships for export is 15 cents per ton more for sacked grain than for bulk grain. In both cases the operation of delivering grain to the ship ends with depositing the grain over the ship's side and does not include the stowing work done by stevedores. The total saving under this item that could have been made during the 8-year period if the 2,576,935 tons of grain loaded as sacked grain had been loaded as bulk grain, is \$386,540. (Figs. 17 and 18.)



FIGURE 14.—Piling sacked grain, unloaded from cars at a terminal warehouse

(9) Facilitates weighing and inspection of export grain. The charge for weighing and inspection of bulk grain for export is 2 cents



FIGURE 15.—Bulking sacked grain at a terminal elevator



FIGURE 16.—Resacking wheat that has been scoured to remove smut, at a terminal warehouse

a ton less than that for sacked grain. The saving on this item on the 2,576,935 tons would have been \$51,539 had the grain been handled to the ship in bulk instead of in sacks.

(10) Facilitates stowing grain in ship. The published tariff of the stowaging companies at Portland is 50 cents a ton for stowing

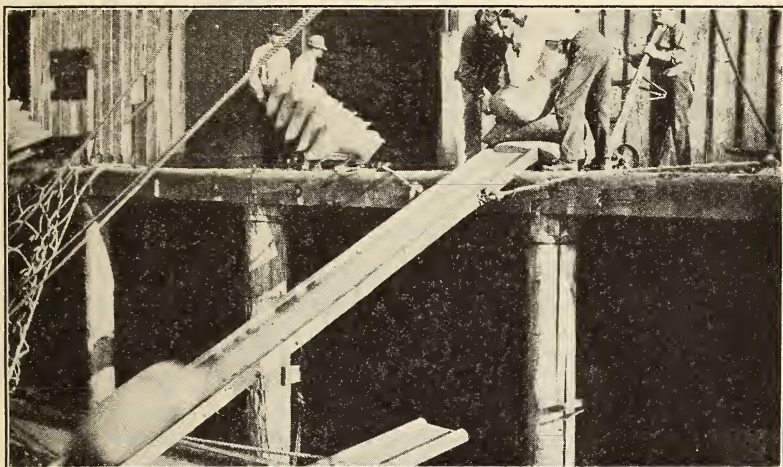


FIGURE 17.—Loading sacked grain on board ship for export

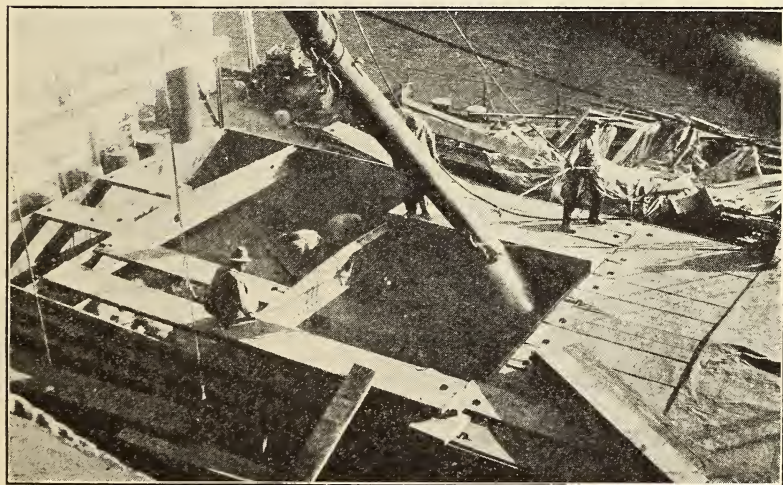


FIGURE 18.—Spouting bulk grain into the hold of a vessel

grain in boats in sacks and only 20 cents a ton for bulk grain. Based on the export tonnage of sacked grain, for the eight years, which was 2,576,935 tons, the saving would have amounted to \$773,080.

Saving that could have been made in 8-year period if grain had been handled in bulk

Summary of items 1 to 10:

1. Bad-order sacks and resacks.....	\$407, 020
2. Sampling, weighing, and grading grain.....	117, 574
3. Bulking smutty wheat received in sacks.....	730, 136
4. Freight on sacks.....	130, 638
5. Loading cars at country points.....	1, 175, 743
6. Unloading cars at terminals.....	1, 304, 590
7. Resacking wheat after scouring to remove smut.....	533, 426
8. Delivering grain to ships.....	386, 540
9. Weighing and inspection of export grain.....	51, 539
10. Stowing grain in ship.....	773, 080
Total.....	5, 610, 286
Average per year.....	701, 286

On the basis of these 10 items applying to the total sacked wheat received at Portland and Astoria for the 8-year period, amounting to 195,957,177 bushels or 5,878,715 tons, if bulk handling had been used there could have been an average saving of 2.863 cents per bushel, or 95.43 cents per ton. (It should be noted that 41.4 per cent of this sacked grain was smutty.)

DIFFERENCE IN COST OF SACK AND BULK HANDLING

The differences in the cost of harvesting, handling, and marketing smutty wheat in sacks and in bulk from the time the grain leaves the combine or threshing machine until it is delivered to the hold of a ship, as determined on the ton-unit basis of charges, are shown in Table 7.

TABLE 7.—*Saving made by using bulk method of marketing, for export, on a ton of smutty wheat*¹

Item	Cost per ton for marketing grain		Saving by bulk method
	In sack	In bulk	
	Dollars	Dollars	Dollars
Operation on farm:			
Labor on harvester.....	2.88	1.06	1.82
Hauling (contract rates estimated 50 cents a ton less for bulk grain).....			.50
Sacks at 14 cents each, twine at 0.5 cents a sack.....	2.175	0	2.175
Operation from country shipping point to ships:			
Bad-order sacks and resacks.....	.069	0	.069
Sampling, weighing, and grading grain.....	.06	.04	.02
Smutting charges for 0.5 to 1 per cent smut dockage.....	.75	.45	.30
Freight on sacks.....	.023	0	.023
Loading cars at country points.....	.35	.15	.20
Unloading cars at terminals.....	.60	.40	.20
Resacking wheat after scouring to remove smut.....	.50	0	.50
Delivering grain to ship.....	.25	.10	.15
Weighing and inspection of export grain.....	.06	.04	.02
Stowing grain in ship.....	.50	.20	.30
Total.....			6.277
Summary of possible saving per ton and per bushel by bulk handling of—			
Smutty wheat—			
Saving per ton.....			6.277
Saving per bushel.....			.188
Saving per bushel after deducting discount of 3 cents per bushel on bulk wheat ²			.158
Smut-free wheat—			
Saving per ton.....			5.477
Saving per bushel.....			.164
Saving per bushel after deducting the discount of 3 cents per bushel ² on bulk wheat....			.134

¹ Determined on the basis of a saving of \$0.99 per acre for yields averaging 18.16 bushels per acre, as shown in Table 4.

² The Pacific Northwest Grain Dealers' Association has adopted a schedule of discounts each year at their annual convention, which has been used by the members when purchasing grain in the country. Many years ago when bulk grain was first delivered by the farmers, sacked grain was declared to be the basis of all contracts, and bulk grain was accepted at a discount. The bulk-grain discount has varied from 9 cents per bushel to the present discount, which for a number of years has remained at 3 cents per bushel. California has a generally accepted discount for bulk grain of 5 cents per 100 pounds.

Table 7 also summarizes the saving that would result from harvesting and marketing 1 ton of smutty wheat and 1 ton of smut-free wheat in bulk instead of in sacks from the combine to the hold of the vessel. This summary shows that a saving of approximately 13.4 cents per bushel for smut-free wheat and 15.8 cents per bushel for smutty wheat, can be realized by using the bulk system instead of the sack system of handling grain from thresher to ship when the cost and handling charges correspond to those used in this study. The above figures cover only those operations for which costs have been determined definitely. However, there are given below a number of additional advantages that may accrue from bulk handling.

OTHER ADVANTAGES AND ECONOMIES OF BULK HANDLING

Other advantages of bulk handling, in addition to those already listed, are gained directly or indirectly by the farmer and the grain trade. Although no attempt is here made to estimate the value per ton of these advantages, each reader can, in his own way and for his particular conditions, estimate a value for these items.

(1) Decreases damage by rats and mice. Modern bulk-grain storage plants at terminal points are usually constructed of rodent-proof material, and this is also generally true at country points, whereas a pile of sacked grain stored in a wooden warehouse is an ideal place for rats and mice to thrive. As a result, most warehouses where sacked grain is stored are infested with these pests. Rodents cause damage to sacked grain stored in a warehouse by cutting open or tearing some of the sacks, and as a result the grain spills out of the sacks. This often causes the pile of sacks to tumble down. Extra expense in handling such grain is caused by the necessity of resacking the spilled grain in new sacks and in repiling the sacks. The longer sacked grain remains in storage in warehouses that are infested with rodents the more serious the damage becomes. Bulk grain can be stored in bins with little or no damage from rodents, and this is particularly true when the grain is stored in concrete, metal, or other rodent-proof bins.

(2) Decreases damage by rain. When grain produced in the Pacific Coast States is sacked at the combine the sacks are usually left lying in the field for a period of time, after which the sacks are frequently picked up and piled in the open along the roadside. When grain in those States is threshed with a stationary threshing machine and the threshed grain is put into sacks, the sacked grain is usually piled in the open at the place at which it is threshed. Unprotected sacked grain piled in the open is occasionally damaged from rain. Such damage at times becomes serious during early rainy seasons in the Pacific Northwest. The damage to sacked wheat caused by rain points to the possibility of the bulk system as insurance against such losses.

(3) Provides screenings and dockage for feed on farm and saves freight. It is not usually practicable to clean dockage from sacked grain on the farm because of the expense of unsacking and resacking the grain and repiling the sacks. Grain in bulk can be cleaned readily and rapidly. This puts the grain in better market condition, makes it possible to keep the screenings on the farm for stock feed, and saves the cost of the freight on the screenings.

(4) Decreases field losses. There are many field losses in the use of the sack method. The value of the sack of grain, the ease with which such a parcel can be taken, and the difficulty in apprehending the thief, and in identifying the sack, all contribute to the occasional loss of sacked grain by theft during harvest seasons. Night watchmen are often employed to guard fields containing sacked grain. When grain is threshed in bulk it is placed immediately in storage, which materially decreases the possibility of theft.

Livestock occasionally get into fields of grain before the sacks are collected or removed. This results in a loss of grain and at times a loss of the stock from gorging.

Fires are frequent in grain stubble. When fires occur before the sacked grain is collected there is a loss of grain.

It is sometimes desirable to cut as little straw as possible when harvesting grain with a combine. The high stubble hides the sacks so that some may remain uncollected.

More grain dribbles from sacks hauled on sacked-grain racks than is lost from grain-tight bulk-grain boxes.

(5) Reduces insurance charges on stored grain. Storage bins for bulk grain are usually of fireproof construction, whereas warehouses for handling sacked grain are usually either entirely or partly constructed with lumber and are not entirely fireproof. Bulk grain in fireproof storage carries an appreciably lower insurance rate than is applied to sacked grain in the usual flat warehouse which is not fireproof.

A certain country shipping point in California, for example, has a sacked-grain warehouse and a grain elevator. They are located opposite each other on the same railroad track. The insurance rate on bulk grain in the elevator, the bins of which are made of metal on concrete foundations, is 49 cents per year per \$100 of value. The lowest insurance rate on sacked grain in any other grain warehouse in the town, so far as could be determined, was \$1.12 per year per \$100 of value. None of the sacked-grain warehouses at this shipping point were entirely fireproof.

In the San Francisco Bay section the insurance rate on bulk grain stored in a terminal concrete elevator is approximately 19 cents per year per \$100 of value. At a lumber-constructed grain warehouse in the same section the insurance rate on sacked grain is \$1.76 per year per \$100 of value. The rate for sacked grain in the second case is approximately nine times the rate for grain stored in bulk at the elevator. With grain valued at \$1.50 per 100 pounds the bulk system in this instance would produce a saving of approximately 1 cent per bushel per year on insurance cost.

(6) Facilitates conditioning. Bulk grain is more readily conditioned than is sacked grain, no matter what the defect is that necessitates attention. Grain that is to be cleaned, "smutted," washed, blended, or "Jessed" commercially must be in bulk; and if weevil or other injurious insects infest a lot of grain, they can be exterminated much more easily if the grain is in bulk than if it is in sacks. If sacked grain in a pile begins to heat, it is very difficult and expensive to arrest the heating to prevent the grain from spoiling, but bulk grain that is heating can usually be cooled by moving the grain from one bin to another with either a stationary or a portable elevator—a simple and comparatively inexpensive operation.

Smutty grain can be handled in sacks with less breaking up and smearing of the smut on the wheat kernels than it can when handled in bulk. This, in former years when the smut was removed by means of scouring machines, was somewhat of an advantage in the exporting of slightly smutty wheat and was also an advantage where there was some domestic use for slightly smutty wheat by mills that bought wheat and scoured it as a regular part of the milling procedure. In recent years, however, smut-washing machines have come into almost universal use in the Pacific coast markets, and the breaking up of the smut balls through bulk handling is now beneficial for the reason that the smut can be removed more efficiently by washing when it is present in the form of spores and small pieces of smut balls than it can if it is present in the form of balls. The washing process also results in a gain in weight of the wheat through its absorption of a small quantity of water while it is being washed, whereas the scouring process always resulted in a loss in the weight of the grain.

The conditioning and blending operations can be performed not only more readily but also more economically when the grain is handled entirely in bulk.

The blending that the grain receives when it is handled in bulk increases its uniformity and this prevents the usual discounts for "off-grade" sacks when the grain is sold and delivered.

(7) Saves in railroad transportation. Cars of bulk grain are loaded and unloaded at modern bulk-handling plants in much less time than it takes to load and unload cars of sacked grain at a warehouse or elevator. In moving grain from the country to the terminal in the rush season, the railroads are often hampered in their operations by a shortage of cars. Yards at terminals are frequently so full of cars of grain that an embargo is placed on the further movement of grain to the terminals until the congestion is relieved. When such a condition exists at Pacific coast points, it is often due to the slow rate at which sacked grain is unloaded. Cars of grain are loaded to capacity more easily when the grain is in bulk than when the grain is in sacks. The breaking of sacks in poorly coopered cars brings additional losses. Efficiency of freight cars on Pacific coast railroads would be increased if all the grain were handled in bulk from the country to terminals.

(8) Reduces terminal storage charges. There appears to be a general impression among grain growers unfamiliar with elevator conditions that the cost of storing bulk grain in a terminal elevator is more than the cost of storing sacked grain in a terminal warehouse. This may be true in some instances in country plants, but storage rates at Pacific coast terminal elevators show a tariff of 0.5 cent per ton per day for bulk grain and 0.75 cent per ton per day for sacked grain after the 20-day free storage period.² The storage rate for sacked grain at these terminals is therefore 50 per cent more than the rate for bulk grain. On the basis of these rates, the saving in one year through the use of bulk storage instead of sack storage for wheat would amount to about 90 cents per ton, or approximately 3 cents per bushel.

(9) Saves at shipside. The value of the time of a steamship is figured at from \$250 to \$1,000, or more, per day; anything that will shorten

² See item 214, Tariff No. 9, Commission of Public Docks of the City of Portland; also item 1036, of Tariff Circular of Port of Seattle, Wash.

the time in port is of great interest to steamship companies. With up-to-date facilities, a modern elevator can load grain into a ship at a much faster rate than sacked grain can possibly be put aboard. An 8,000-ton ship can be loaded at some of the Pacific coast terminal elevators with bulk grain in from two to three days, whereas to load such a ship with sacked grain usually requires a week or more.

The saving of time accomplished by the bulk system at the ship also reduces the interest and cost of insurance on the grain by shortening the time the grain is in port during the loading process.

In loading sacked grain into ships many sacks are damaged by the ship's sling or conveyor operations. Then, too, a certain proportion of the sacks are slit open purposely so that the spaces between sacks in the hold can be filled with loose grain, thus making more nearly complete use of the chartered space. None of this waste occurs in shipments of bulk grain, and the chartered space is used to maximum capacity.

The shipping company employs checkers for counting the sacks as they are delivered to the ship. A man is stationed at each hatch into which grain is being delivered to count the sacks being put aboard, as a protection to the owners of the ship in the event of claims for damage. This expense is eliminated by bulk handling.

SACK HANDLING DESIRABLE FOR SOME PURPOSES

Special trade requirements sometimes demand that the grain be sacked. Occasionally farmers and dealers may have small lots of particularly choice grain that will command a high premium in the markets; and to be sure that such grain will not be mixed with other grain they may prefer to handle, store, and sell such lots of grain in sacks. Sacking can usually be done more cheaply and more satisfactorily at a bulk-storage plant on the farm or at an elevator at the time of shipment than at the thresher. Some large ranch owners on the Pacific coast harvest their grain in bulk but have the grain sacked at their farm elevators to meet the demand for sacked grain. This enables them to reduce their harvesting costs to a considerable extent. Before sacking, the bulk grain is put into excellent marketing condition by a recleaning process at the farm elevator. This system also assists in making the grain in the sacks of more uniform quality. The recleaned grain is sacked at less cost at the farm elevator than if it were sacked at the threshing machine because fewer sacks are required and labor is used more efficiently. Moreover, the grain sacks are handled less and sunburning is eliminated, so there is less loss from leaking sacks and the number of bad-order sacks and resacks at the country and terminal warehouses is reduced.

Occasionally small lots of grain are to be exported, and at times so-called "distress or broken space" in steamships can be bought cheaply and used to advantage in exporting small parcels of grain. This kind of shipping space is often not suitable for bulk grain without an expenditure for bulkheading, but sacked grain can be loaded into such space conveniently and without bulkheading. Facilities for sacking grain are available at practically all terminals on the Pacific coast; hence, supplying sacked grain for such distress space is a simple matter at the terminal.

European importers of California malting-type barley are accepting occasional lots in bulk although it is claimed that they generally prefer that such barley be shipped in sacks.

On those Pacific coast farms where the grainfields have very steep hillsides it is occasionally more convenient to handle combine-harvested grain in sacks than in bulk. However, modern harvesting machinery equipped with a leveling device makes it possible to harvest grain in bulk on the steepest hillsides. The grain can always be discharged from a combine bin into a wagon or truck at some accessible place in the field. (Fig. 19.)

ECONOMICAL GRAIN MARKETING A WORLD MOVEMENT

The bulk-grain system originated in the United States and is known the world over as the American system. Representatives of foreign grain-producing countries have traveled through the United States



FIGURE 19.—Combine handling grain in bulk on a steep hill. The grade of this field was approximately 37 per cent

and Canada carefully studying the efficient bulk-grain handling methods. These representatives have quickly recognized the advantages that our cheap grain handling has given the American producers. On returning home, they have enlisted the assistance of their respective Governments in providing efficient bulk-grain handling facilities in order that their farmers might continue to export their surplus grain profitably. Many of the export grain-producing countries have, in the past, handled their grain in bags.

Indications are that the grain interests of practically all of the surplus wheat-producing areas of the world who have handled grain largely in sacks are struggling with a grain-handling problem similar to the one on the Pacific coast; that is, the change from sack to bulk handling.

In Argentina, railway interests are negotiating with a British company for the construction of a chain of country and terminal grain

elevators. The plans of construction are patterned after the elevators of the United States and Canada.

The Union of Soviet Socialistic Republics, formerly Russia, is planning to take its pre-war place in the wheat markets of the world. Some of the best American engineers and economists have been called to Russia for consultation and work on the problem of putting into production large areas of now undeveloped land. It is planned that the grain will be handled in bulk in the field and through modern grain elevators. It is significant that the Russian investigators who studied the grain-handling systems of this country did not give the sack-handling system of the Pacific coast any consideration in their plans for the development of their grain-marketing program. An American company that has specialized in the building of grain elevators and flour mills has been awarded contracts aggregating approximately \$110,000,000 to build elevators, flour mills, and miscellaneous industrial structures in the Union of Soviet Socialistic Republics.

Australia is in the process of changing its method of grain handling from sacks to bulk. This development is being hastened by governmental assistance in the designing, financing, and building of a carefully planned system of country and terminal elevators. The wheat production of Australia has doubled within the last few years. New South Wales has now provided modern bulk elevators at 84 country stations, aggregating over 15,000,000 bushels in capacity. Sydney is provided with bulk-elevator space totaling 6,750,000 bushels in capacity. It is reported that 30 per cent of the New South Wales grain is now handled in bulk.

South Africa is following the plan of Australia in providing Government-owned and operated bulk elevators for its grain interests. The bulk system is partly installed in Africa, and there is a popular demand for its rapid extension which at present would necessitate an expenditure of \$3,500,000. Present bulk facilities are being crowded beyond their ability to handle the grain.

Practically all of Canada's grain is handled in bulk. The problem is to provide the necessary additional elevators for the rapidly increasing production. The Dominion's rapid growth in wheat production, from 55,000,000 bushels in 1910 to 440,000,000 bushels in 1923, made it necessary for the grain interests to build hundreds of new country elevators each year. These country elevators are feeders for the vast terminal grain elevators at seaboard, which are among the largest grain-handling plants in the world. Before the World War Canada furnished about 11 per cent of the world's grain exports; to-day it claims to be furnishing over 50 per cent of the export grain needs. An efficient bulk-grain handling system is undoubtedly a large contributing factor in this phenomenal increase in grain production.

In the United States all the grain produced east of the Pacific Coast States has been almost entirely handled in bulk on the farm, at the country stations, and at terminal markets, for many years. Although the grain produced in the Pacific Coast States is still largely handled in sacks on the farm and at the country stations, rapid progress is being made in the adoption of the bulk-handling method. Some of the brewing types of barley have, during recent years, been exported in bulk from the Pacific coast markets, but most of such barley is still exported in sacks. With the exception of barley nearly

all of the grain that is shipped from the Pacific coast markets in either domestic or foreign commerce is now being put aboard vessels in bulk.

CONCLUSIONS

In practically every movement of grain in its journey from the field to its destination at the terminals the charges and costs for handling of grain in bulk are lower than the charges and costs for handling sacked grain. There appears to be sufficient saving to make the change from sack to bulk handling desirable for everyone connected with the grain industry. Farmers have much to gain in the reduced cost of harvesting and handling bulk grain on the farm. The country grain dealers, by changing to bulk grain, can save in the cost of handling and then can conveniently add valuable services such as cleaning, washing, scouring, and otherwise conditioning the grain, and preparing seed. The railroads would gain by having their freight cars used more efficiently through reduction in idle time in loading and unloading and by the loading of the cars to their full capacity. The terminal grain dealers and exporters could greatly increase their capacity for rapid receiving, conditioning, and shipping of cargoes with marked economy if they used the bulk method. The steamship companies can receive and discharge cargoes of grain much more rapidly when the grain is in bulk, thus shortening the ship's time in port.

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